

Inter-Agency Conference on Metabolic Engineering 2005

3 Feb 2005

Introduction of Prof. John W. Frost

by

Dr. Harold J. Bright

ONR Molecular Biomimetics Program



Green Synthesis: Connecting DNA Sequence Space with Chemical Manufacture

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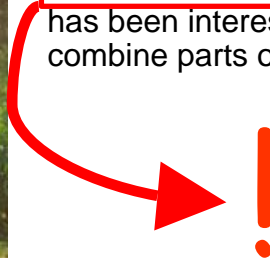
Propelling Research

By MEGHAN GILBERT

The State News

A team of three MSU scientists has found a way to use bacteria in order to make the chemical used to propel Navy Hellfire missiles.

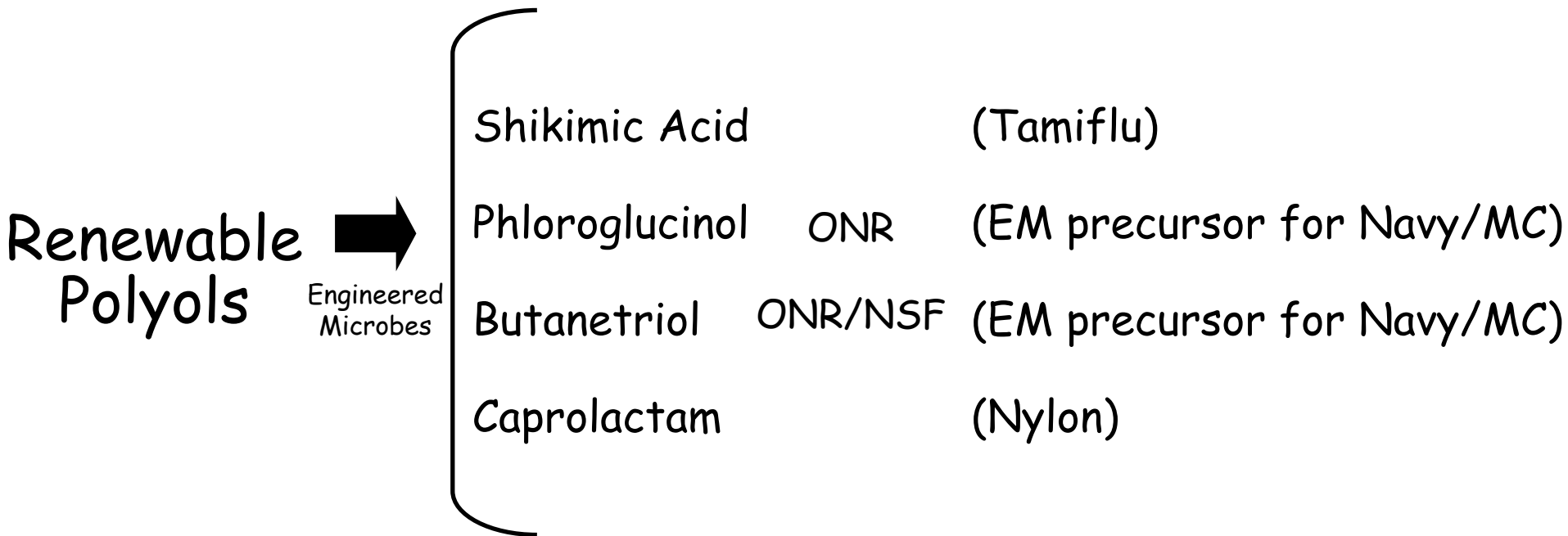
Chemistry professor **John Frost**, who grew up in Illinois around the time Penicillin was discovered, always has been interested in biosynthesis, the biological way to combine parts of elements to form a whole.





The Portfolio

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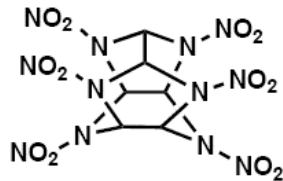




Rationale for Navy/MC Green Synthesis of Energetic Materials

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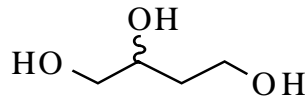
State of the EM Art



CL-20

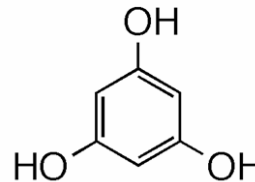
Biocatalytically Impossible!

Realistic Targets



BT

(BTTN precursor)



PG

(TATB precursor)

Bionitration

Issues

- Economics of EM manufacture
- Feedstock security - BT and PG are now available only in China/India
- Coordination with ATK-Thiokol on PG → TATB
- Strong dual-use is essential to get industry involved in bioprocessing (e.g. chiral synthons in BT biosynthesis are cholesterol drug intermediates; PG → catechol, a high volume coating)



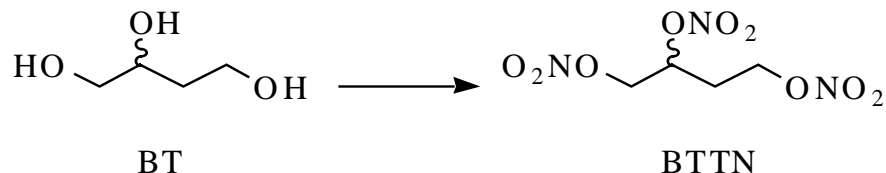
Green Synthesis of Navy/MC Energetic Compounds: Butanetriol (BT) as a Case Study

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*J. Frost, Michigan State U.
Also NSWCIH, Michigan Biotech Inst.*

BTTN:

- made from BT (now from China!)
- used in propellants (e.g., Hellfire, 15K lb/yr)
- better than nitroglycerin (NG, >5M lb/yr)
- hasn't replaced NG because BT is ~ \$40/lb owing to dirty BT synthesis



Engineer Cost-Effective Microbial BT Synthesis

- no metals, organics, salt streams
- no high temperatures or pressures
- single, engineered microbe
- renewable biofeedstocks ($\text{CO}_2 \rightarrow$ sugars)



Bottom Line:

- microbial synthesis of BT at \leq \$10/lb that meets military specs



Phloroglucinol → TATB

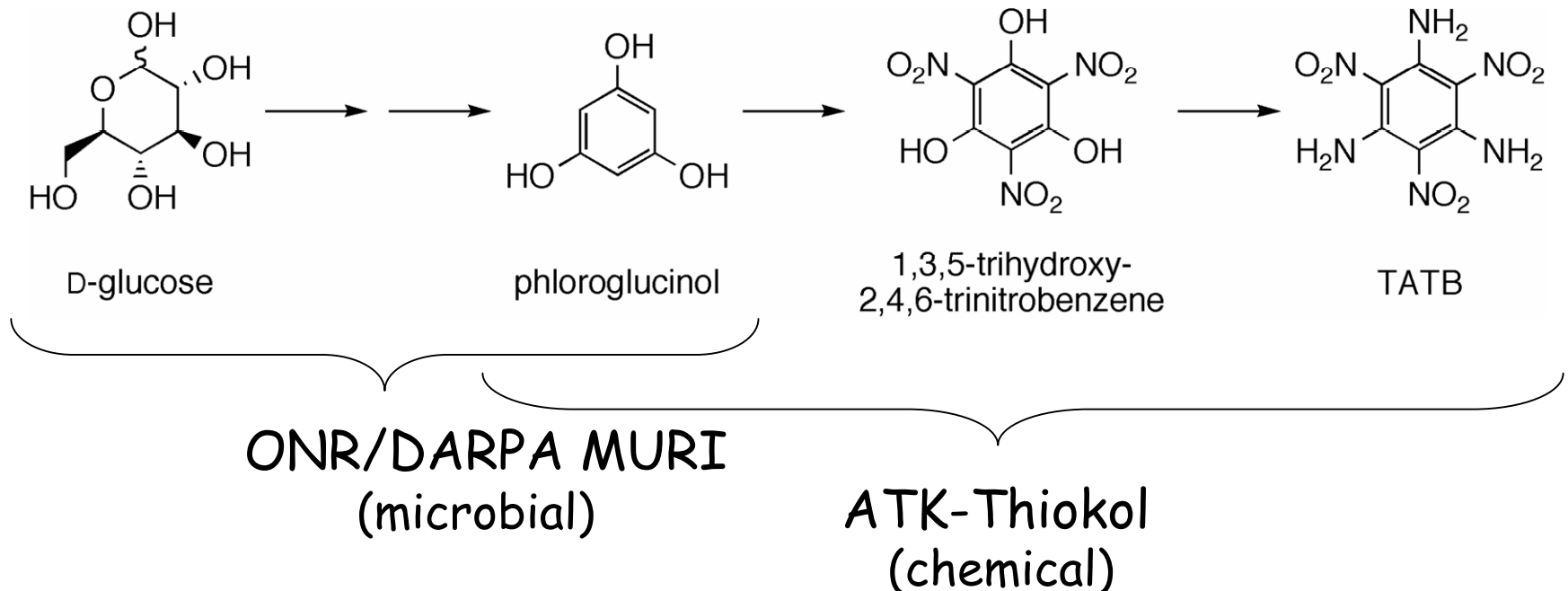
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MURI

J. Frost, Michigan State U.

Also Integrated Genomics, U. Illinois, Rice U.

- Microbial production of PG from glucose at 1g/liter
- This permits collaboration with ATK-Thiokol



- TATB will then be from domestic source